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## Description

The present invention relates to upright pianos and the like stringed keyboard instruments. In particular, the invention relates to a piano comprising a frame, a plurality of taut strings supported in the frame and extending over a bridge and a soundboard coupled to the bridge, wherein the soundboard comprises a rigid member freely suspended relative to the frame by mounting means which enable the rigid member to move towards and away from the frame at least in the region of the bridge.

In a conventional upright piano, the strings are mounted on a massive rigid frame and near their lower ends they extend over bridges which are attached to a soundboard rigidly secured to the piano casing and usually constituted by the back of the piano. Traditional soundboards are made of planks about 10 mm thick laid edge to edge and braced at right angles by bars which run under the bridges. Great care is taken to select wood with high sound propagation rates and low internal damping. Overstringing is common because it allows a better bridge position on the sound board.

In order to improve the quality of the sound, it has been earlier proposed in US—A—3 312 136 to for the soundboard as a freely suspended rigid member, which is capable of operating in a manner analogous to the vibratable membrane of a loudspeaker.

The conventional frame used in a piano is extremely heavy and is rigid to withstand the considerable force exerted by all the tensioned strings. This has naturally contributed to the cost of the instrument.

The present invention seeks to provide a piano wherein the frame on which the springs are mounted may be made lighter and therefore less expensive, while still being able to withstand the force of the strings.

In accordance with the present invention, the frame of the piano is of tubular construction and includes tubes arranged between the strings and lying in the same plane as the strings, the bridges being connected to the strings by way of distance pieces.

It has been suggested in US—A—1,929,030 to strengthen a frame by means of ribs but these ribs differ from the present invention in that it is important for the strengthening of the frame to lie in the same plane as the strings, as there would otherwise be a tendency for the frame to bow.

On account of the construction proposed in the invention each small group of strings is effectively framed separately and there is no longer the need for a long unsupported agraffe to withstand the tension of all the strings. Consequently, the frame members need not be as heavy and as rigid as in the prior art constructions.

Because of the presence of frame members between the strings, the strings cannot be connected directly to the bridges. For this reason, distance pieces are interposed between the strings and the bridges.

The distance pieces may conveniently be manufactured as an aluminium extrusion. Aluminium lends itself particularly well to such an application because of its acoustic properties and low density.

In the case of a relatively small soundboard, the rigid member may be flexibly mounted about its entire periphery in the same manner as a loudspeaker cone but for larger soundboards the rigid member is preferably pivotable about an edge remote from the attachment to the bridge.

A problem that arises with a conventional soundboard, is that the base notes tend to lose volume because their bridges are too near the edge of the soundboard and the treble notes lose volume because of the weight of the soundboard.

To mitigate this last problem, it has been suggested in DE—C—572 489 to form a rigid soundboard from several boards of different sizes and each having its own bridge.

In the preferred embodiment of the invention, a piano comprises three bridges each connected to a respective soundboard. The soundboard for the base notes is pivotably mounted along a line remote from the bridge whereas the remaining two soundboards are flexibly supported in a rigid box by compliant mounting means extending about their peripheries.

In substituting the flexibly mounted vibratable member for the traditional soundboard, it is possible to draw on the experience in loudspeaker design not available to early piano designers.

The rigid box may be in the form of a closed box so as to use infinite baffle techniques and the box may be constituted by the casing of the instrument. Alternatively, the box may have a front opening and a base baffle in the manner used in some conventional loudspeakers.

It is well known that many loudspeakers separate low, medium and high frequencies in order to optimise the design. The same technique is used in the preferred embodiment of the invention by arranging a plurality of vibratable members each covering a different range of frequencies.

Since the vibratable members are similar to loudspeaker discs or cones, it is possible for each member to cooperate with an electrical coil which may act as a drive, a pick-up or both.

The coil when used as a pick-up can enable sound recordings to be made directly from the soundboard of the piano. When used as a drive, it can, for example, enable a recorded piece of music to be reproduced while superimposing on the sound played back the notes manually played on the instrument. A still further possibility is that the sound produced by the strings may be modified by feedback whereupon special effects can be produced such as a swell effect.

To assist in the playing of background music, it is possible to incorporate in the instrument a playback device such as a tape recorder.

In a conventional upright piano, the proximity of the soundboard to the strings prevents any elements of the piano action from being positioned in this space. The optimum position for the

dampers on a piano is immediately opposite the line of impact of the hammers. In a grand piano, this is readily achieved in that the strings are struck from below whereas the dampers rest on the strings from above under the action of gravity and are raised when the keys are depressed. However upright pianos have hitherto only been overdamped or underdamped, depending on whether the dampers act above or below the line of impact of the hammers and this has generally been acknowledged as inferior.

According to a preferred feature of the invention, the dampers for the strings are arranged in the space between the strings and the soundboards at the same level as the line of the hammers. The dampers may be actuated by means of extensions either of the piano keys or of the wippen, the extensions being arranged to extend between the strings.

The action of the piano may conveniently be mounted on a reinforcement bar connected between the tubes. Because the strings are divided into groups by the tubes reinforcing the frame, a modular approach may be adopted for the design of the action since a group of hammers may be separately formed and assembled on these tubes to strike the strings of the notes in that group. In this manner, the construction, initial assembly and repair of the action may be considerably simplified, to reduce the cost of the instrument.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic view of a piano frame.

Figure 2 shows schematically the attachment of the bridges shown in Figure 1 to soundboards.

Figure 3 shows the mounting of the soundboard for base notes.

Figure 4 shows the mounting for the other two soundboards in Figure 2, and

Figure 5 shows the attachment of a string to a bridge.

In Figure 1, there is shown a frame which is made up of tubes. The frame (11) comprises an agraffe 10 to which all the piano strings 12 are connected by the usual arrangement for permitting the strings to be tuned. Unlike a conventional frame, the agraffe 10 is supported along its length by means of tubes 14 which form a grid extending between the strings 12. The frame is further strengthened by means of a bar 16 connected both to the outer members of the frame and to the tube 14. The bar 16 may serve to mount the action including the hammers etc. for striking the strings but this is not shown. Figure 1 also shows schematically the position of three bridges designated 20, 22 and 24 which are connected to the strings in a manner described below. Each string 12 is connected at its two ends to the frame but is stretched over a respective bridge which is not mounted on the frame but on a movable soundboard. The effective length of the string which determines the

sound produced when the string is struck is the length between the bridge and the agraffe 10.

The soundboards are rigid boards which are designed not to flex but to vibrate as a rigid body when a string is struck, to amplify the sound produced by the strings 12. The soundboard for the base notes, designated 30 in Figures 2 and 3, has the bridge 20 mounted at its lower end while at its upper end it is flexibly mounted on a hinge 31 which is secured to a rigid sound box 33. The sound box 33 is constituted by the casing of the piano. Around its periphery the soundboard 30 is connected by a flexible diaphragm 35 to the soundbox 33 so that the box acts as an infinite baffle. Thus the sound waves emanating from the side facing the strings 12 propagates in the forward direction while the sound waves in the opposite direction are suppressed. Because of the substantial weight of the soundboard 30, it is preferable to have a hinge at its upper end but the soundboard is nevertheless capable of oscillating as a rigid body to provide amplification. At its lower end, the sound board 30 is connected by the bridge 20 to several strings and this helps to support it.

In the case of the soundboards 32 and 34 in Figure 2 which are connected respectively to the bridges 22 and 24, these are mounted by a compliant support 42 which extends around the entire periphery to a sound box 44. This arrangement is shown in Figure 4. The soundboard 32 acts in a manner directly analogous to a loud-speaker cone.

It will be seen from Figure 1 that each of the bridges crosses one of the tubes 14 arranged between the strings 12. It is important from the point of view of ensuring the strength of the structure that the strings and the tubes be in the same plane. To enable the bridge to be securely mounted to the strings, distance pieces are provided between the bridges and the strings. This arrangement is shown in Figure 5 wherein the bridge 20 is seen to be constituted by an aluminium extrusion 60 having a foot 62 secured to the soundboard 30. A tube 64 acting as a distance piece is arranged between the aluminium extrusion 60 and the string 12. A single string constituting a note (or two strings of the same note where applicable) are sandwiched between the distance piece 64 and a washer 66 which are in turn secured to the aluminium extrusion by means of a bolt 68 or the like. It is thus seen that the tubes 14 do not interfere with the extrusion 60 which constitutes the bridge and straddle the tubes 14.

Within each sound box 33 and 44, there is arranged a moving coil 70 secured to the respective soundboard and movable relative to a fixed magnet 72 to constitute an inductive transducer which can act either as a pick-up or as a drive. When the transducer is used as a drive the soundboard can be operated in the manner of a loud speaker to reproduce background music while the sounds produced by striking the strings of the piano may be superimposed directly onto

the same soundboard.

Alternatively, the inductive transducer may be used as a microphone for recording the music played on the piano or may act as both an inductive pick-up and drive simultaneously. In this case, feed-back circuitry may be employed to modify the natural sound produced by striking the string to achieve swell effects and other special effects. The sound produced may be detected and processed in any manner desired, as known per se, and fed back to the same drive to modify the tone of the piano. As well as producing special effects, this technique can be used to alter the tone of the piano. If for example the feedback signal is constituted by harmonics of the same note of which the relative amplitude may be electronically selected, the instrument can provide some of the versatility of an electronic organ while retaining the advantages of a mechanical action.

The use of aluminium in the bridge is particularly preferred because of its acoustic properties as well as its rigidity and light weight.

The spacing afforded by the distance pieces 64 and the bridge 60 can enable parts of the action of the piano to be incorporated within this spacing. In a preferred embodiment of the invention (not illustrated) this space is used to mount dampers which are arranged level with the strike line of the hammers. The dampers may be pivoted towards and away from the strings by the action of extensions of the keys or the wippens, these extensions passing between the strings. Apart from providing better damping than in conventional upright pianos, such a construction can also permit a shorter piano to be made since the hammers and the dampers are at the same level as opposed to the usual upright piano construction which employs dampers arranged above or below the hammers.

An important advantage of having separate soundboards for different notes is that the weight of the soundboards may be better matched to the strings to which they are connected and there is also more flexibility in the positioning of the bridges on the soundboard. The soundboards themselves may be made of any suitable light rigid material and as with loudspeaker cones they may be suitable shaped or strengthened to resist flexing.

It is possible to use the bar 16 to support the piano action and as the strings are divided into groups by the tubes 14 it is possible for the hammer actions to be made in groups or modules which are separately assembled onto the frame.

#### Claims

1. A piano comprising a frame (10), a plurality of taut strings (12) supported on the frame (10) and extending over a bridge (20) and a soundboard (30) coupled to the bridge (20) wherein the soundboard (30) comprises a rigid member freely sus-

ended relative to the frame by mounting means (31, 35) which enable the rigid member (30) to move towards and away from the frame (10) at least in the region of the bridge (20), characterised in that the frame (11) of the piano is of tubular construction and includes tubes (14) arranged between the strings (12) and lying in the same plane as the strings (12) and in that the bridges are connected to the strings by way of distance pieces (64).

2. A piano as claimed in Claim 1, wherein the piano has a plurality of bridges (20, 22, 24) each connected to a respective soundboard (30, 32, 34).

3. A piano as claimed in Claim 2, in which at least one (30) of the soundboards is supported relative to a sound box (33) by means of a flexible hinge arranged at a location remote from the bridge (20).

4. A piano as claimed in Claim 2 or 3, in which at least one of the soundboards (32, 34) is supported relative to sound box (44) by means of flexible and compliant support means (42) extending about the entire periphery of the sound board.

5. A piano as claimed in Claims 2, 3 and 4, having a first pivoted soundboard (30) connected to the strings of the base notes, and two further soundboards (32, 34) each flexibly supported about its entire periphery.

6. A piano as claimed in any preceding claim, in which an electro-acoustic transducer (70, 72) is connected to the or each soundboard (30, 32, 34).

7. A piano as claimed in Claim 6, in which the transducer is connected to act as a microphone.

8. A piano as claimed in Claim 6 or 7 in which the transducer (70, 72) is arranged to act as a driver for superimposing on the vibration of the soundboard caused by the strings a sound derived from an external electrical source.

9. A piano as claimed in Claim 8 wherein a playback device is incorporated in the piano casing and connected to the transducer (70, 72), to enable play-back of pre-recorded background music using the soundboard as a loudspeaker.

10. A piano as claimed in Claim 8, wherein the transducer (70, 72) is connected to a processing circuit which applies electrical feedback signals derived by processing signals produced by the struck strings.

11. A piano as claimed in any preceding claim, in which each bridge (20, 22, 24) is formed as an aluminium extrusion.

12. A piano as claimed in any preceding claim, wherein dampers for damping the strings are mounted in the space between the strings and the sound boards at the same level as the strike line of the hammers.

13. A piano as claimed in any preceding claim, in which the tubes (14) are interconnected by means of a bar (16) also serving to mount the action of the piano.

14. A piano as claimed in Claim 13, in which the piano action is formed of a plurality of modules each having a predetermined number of hammers associated with the strings arranged between a pair of adjacent tubes (14).

## Patentansprüche

1. Ein Klavier, umfassend einen Rahmen (10), eine Vielzahl gespannter Saiten (12), die mit dem Rahmen (10) verbunden sind und über einen Steg (20) verlaufen, und einen mit dem Steg (20) verbundenen Resonanzboden (30), wobei der Resonanzboden (30) ein starres Element umfaßt, das im Verhältnis zum Rahmen frei beweglich aufgehängt ist, und zwar über Befestigungsvorrichtungen (31, 35), die es ermöglichen, daß sich das starre Element (30) zumindest im Bereich des Stegs (20) auf den Rahmen (10) zu und von diesem weg bewegen kann, dadurch gekennzeichnet, daß der Rahmen (11) des Klaviers röhrenförmig ausgeführt ist und Röhren (14) umfaßt, die zwischen den Saiten (12) angeordnet sind und auf gleicher Ebene mit den Saiten (12) verlaufen, und dadurch, daß die Stege über Abstandshalter (64) mit den Saiten verbunden sind.

2. Ein Klavier gemäß Anspruch 1, wobei das Klavier eine Vielzahl von Stegen (20, 22, 24) aufweist, die jeweils mit einem entsprechenden Resonanzboden (30, 32, 34) verbunden sind.

3. Ein Klavier gemäß Anspruch 2, bei dem mindestens einer (30) der Resonanzböden über ein vom Steg (20) entfernt angeordnetes flexibles Gelenk im Verhältnis zu einem Resonanzkörper (33) abgestützt ist.

4. Ein Klavier gemäß Anspruch 2 oder 3, bei dem mindestens einer der Resonanzböden (32, 34) im Verhältnis zum Resonanzkörper über eine flexible und nachgebende Haltevorrichtung (42) abgestützt ist, die rund um den Resonanzboden herum verläuft.

5. Ein Klavier gemäß Anspruch 2, 3 und 4, das einen ersten drehbar gelagerten Resonanzboden (30) aufweist, der mit den Saiten der Grundtöne verbunden ist, sowie zwei weitere Resonanzböden (32, 34), von denen jeder entlang seines gesamten Umfangs flexibel abgestützt ist.

6. Ein Klavier gemäß irgendeinem der vorstehenden Ansprüche, bei dem der Resonanzboden oder jeder der Resonanzböden (30, 32, 34) mit einem elektroakustischen Wandler (70, 72) verbunden ist.

7. Ein Klavier gemäß Anspruch 6, bei dem der Wandler so angeschlossen ist, daß er als Mikrofon dient.

8. Ein Klavier gemäß Anspruch 6 oder 7, bei dem der Wandler (70, 72) so angeordnet ist, daß er die Funktion eines Treibers übernimmt, um die durch die Saiten verursachte Schwingung des Resonanzbodens durch einen außerhalb dieses Bodens elektrisch erzeugten Klang zu überlagern.

9. Ein Klavier gemäß Anspruch 8, bei dem eine Playback-Vorrichtung in das Klaviergehäuse eingebaut und mit dem Wandler (70, 72) verbunden ist, um die Wiedergabe zuvor aufgenommener Hintergrundmusik zu ermöglichen, wobei der Resonanzboden als Lautsprecher benutzt wird.

10. Ein Klavier gemäß Anspruch 8, bei dem der Wandler (70, 72) mit einer Regelschaltung verbunden ist, die elektrische Rückkopplungssignale

abgibt, welche durch Regelung der durch das Anschlagen der Saiten entstandenen Signale zustandekommen.

11. Ein Klavier gemäß irgendeinem der vorstehenden Ansprüche, bei dem jeder Steg (20, 22, 24) aus stranggepreßtem Aluminium besteht.

12. Ein Klavier gemäß irgendeinem der vorstehenden Ansprüche, bei dem in dem Zwischenraum zwischen den Saiten und den Resonanzböden auf gleicher Ebene mit der Anschlaglinie der Hämmer Dämpfer angebracht sind, die zur Dämpfung der Saiten bestimmt sind.

13. Ein Klavier gemäß irgendeinem der vorstehenden Ansprüche, bei dem die Röhren (14) über einen Stab (16) miteinander verbunden sind, der auch zur Montage der Klaviermechanik dient.

14. Ein Klavier gemäß Anspruch 13, bei dem die Klaviermechanik aus einer Vielzahl von Modulen besteht, die jeweils eine vorgesehene Anzahl von Hämmern aufweisen, verbunden mit den Saiten, die zwischen zwei nebeneinanderliegenden Röhren (14) angeordnet sind.

## Revendications

1. Piano comprenant un cadre (10), des cordes (12) portées par le cadre (10) et tendues au dessus d'une barrette (20) et d'une table d'harmonie (30) associée à la barrette (20), où la table d'harmonie (30) comprend une pièce rigide librement suspendue relativement au châssis par des moyens de montage (31, 33) qui lui permettent de se rapprocher et de s'éloigner du cadre (10) au moins dans la région de la barrette (20), caractérisé en ce que le cadre (11) du piano est de construction tubulaire et est fait de tubes (14) disposés entre les cordes (12) et placés dans le même plan que les cordes (12) et en ce que les barrettes sont reliées aux cordes à l'aide de pièces d'écartement (64).

2. Piano suivant la revendication 1, caractérisé en ce qu'il possède plusieurs barrettes (20, 22, 24) chacune reliée à une table d'harmonie correspondante (30, 32, 34).

3. Piano suivant la revendication 2, caractérisé en ce qu'au moins une (30) des tables d'harmonies est montée par rapport à une caisse de résonance (33) à l'aide d'une charnière souple disposée en un endroit éloigné de la barrette (20).

4. Piano suivant la revendication 2 ou 3, caractérisé en ce qu'au moins une des tables d'harmonie (32, 34) est montée par rapport à une caisse de résonance (44) à l'aide de moyens de support souples et appropriés (42) qui s'étendent autour de toute la périphérie de la table d'harmonie.

5. Piano suivant les revendications 2, 3 et 4, caractérisé en ce qu'il a une première table d'harmonie basculante (30) reliée aux cordes des notes graves et deux autres tables d'harmonie (32, 34) qui sont chacune montée de manière souple tout autour de leur périphérie.

6. Piano suivant l'une quelconque des revendications précédentes, caractérisé en ce qu'un transducteur électroacoustique (70, 72) est relié à la ou à chacune des tables d'harmonie.

7. Piano suivant la revendication 6, caractérisé

en ce que le transducteur est connecté pour agir comme un microphone.

8. Piano suivant la revendication 6 ou 7, caractérisé en ce que le transducteur (70, 72) est disposé pour agir comme un organe de commande afin de superposer à la vibration de la table d'harmonie causée par les cordes un son produit par une source électrique extérieure.

9. Piano suivant la revendication 8, caractérisé en ce qu'un dispositif de reproduction est incorporé dans le meuble du piano et relié au transducteur (70, 72), afin de permettre la reproduction d'une musique d'accompagnement pré-enregistrée en utilisant la table d'harmonie comme un haut-parleur.

10. Piano suivant la revendication 8, caractérisée en ce que le transducteur (70, 72) est relié à un circuit de traitement qui applique des signaux électriques de réaction en provenance de signaux de traitement produits par les cordes frappées.

11. Piano suivant l'une quelconque des reven-

dications précédentes, caractérisé en ce que chaque barrette (20, 22, 24) est formée comme une protubérance en aluminium.

12. Piano suivant l'une quelconque des revendications précédentes, caractérisé en ce que les étouffoirs servant à étouffer les cordes sont montés dans l'espace situé entre les cordes et les tables d'harmonie au même niveau que la ligne de frappe des marteaux.

13. Piano suivant l'une quelconque des revendications précédentes, caractérisé en ce que les tubes (14) sont interconnectés à l'aide d'une traverse (16) destinés aussi à recevoir le mécanisme du piano.

14. Piano suivant la revendication 13, caractérisé en ce que le mécanisme du piano est constitué de modules qui chacun a un nombre prédéterminé de marteaux associés aux cordes et qui sont disposés entre un couple de tubes contigus (14).

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